LACE, Incorporated
Research and Development of Wired and Wireless LOCAL AREA COMMUNICATION EQUIPMENT

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FEDERAL COMMUNICATIONS COMMISSION
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November 8, 1992

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MAIL BRANCH

The Federal Communication Commission
Washington, D.C. 20554

ORIGINAL
FILE

ATTEN: Office of the Secretary

RE: NPRM and TD GEN Docket No. 90-314 and ET Docket 92-100
Released August 14, 1992

Gentlepersons:

Attached hereto are 15 copies of my Comments on the above referenced Dockets. It would be appreciated if these would be added to the case file.

It is requested that one date-stamped copy be returned to me in the envelope enclosed.

Cordially,

Chandos A. Rypinski

0+13

LACE, INC. — 655 REDWOOD HIGHWAY #340 — MILL VALLEY, CA 94941 USA — TEL: 415 389 6659 — FAX: 415 389 6746

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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MAIL BRANCH

November 9, 1992

In the Matter of	)	
	)	
Amendment of the Commission's Rules to Establish New Personal Communications Services	)))))	GEN Docket No. 90-314 ET Docket No. 92-100

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FEDERAL COMMUNICATIONS COMMISSION
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To: The Commission

COMMENTS OF CHANDOS A. RYPINSKI

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To: The Commission

COMMENTS OF CHANDOS A. RYPINSKI

QUALIFICATIONS OF THE RESPONDENT

My qualifications have been presented in earlier responses to this Docket. I am and have been an active member of IEEE 802.11 Wireless LAN Standards Committee since it was formed. Nonetheless, I do not speak for that Committee or a known constituency within it. I believe that I fully understand the functional objectives of both the computer data and public/private telephone entities. Please consider that I have been part of the development public radio telephone technology until after the introduction of "cellular," and I have served on the 802 LAN Standards Committee for more than 8 years.

SCOPE OF RESPONSE

This response is concerned only with the subject covered in the NPRM and TD paragraphs 41. to 45. and in the proposed section of the Rules 15.243. More specifically, this response relates to the regulatory definition of allowable bandwidth and radio transmitter properties in the proposed 1910-1930 MHz unlicensed communication band.

SUMMARY

Two recommendations are offered both of which are to assign the entire 20 MHz for wideband transmission.

The <u>first</u> recommendation assumes that the three bandwidths are inevitable, and therefore recommends that the two narrower band services be placed at the opposite ends of the 20 MHz, and that the wideband service be centered in the middle of the band with optional 10 or 20 MHz bandwidth.

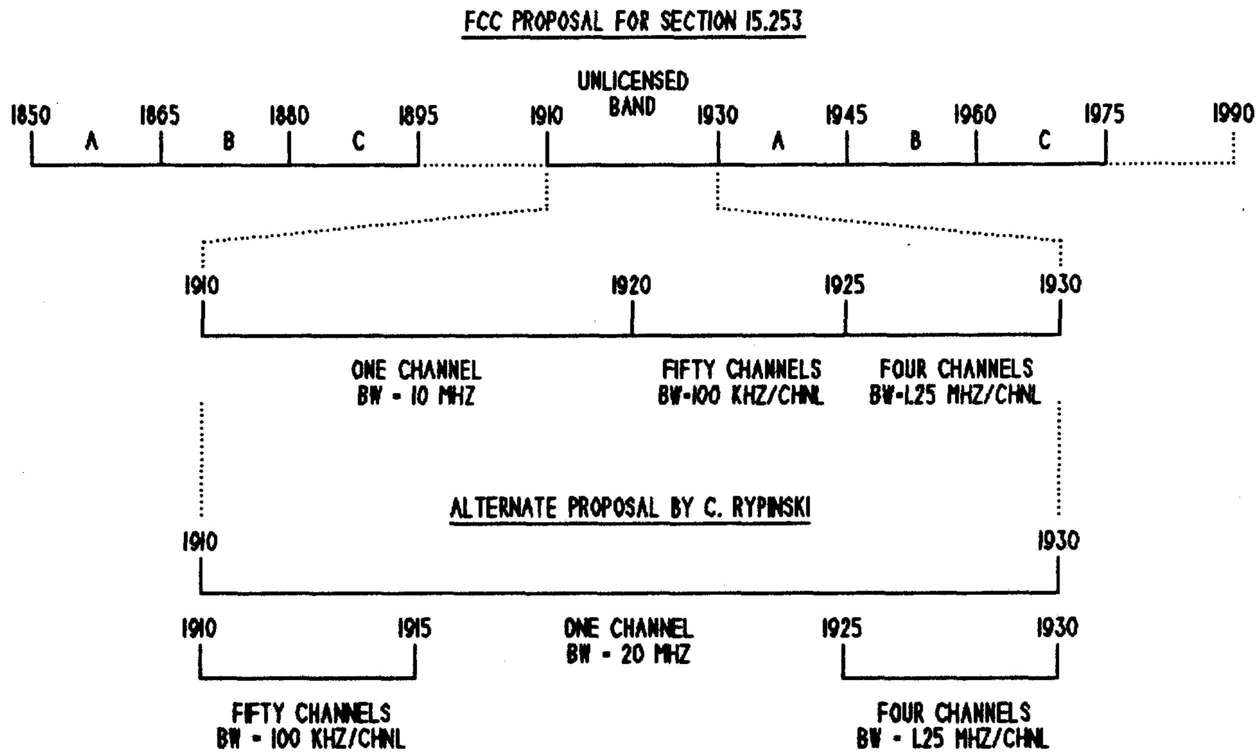
The <u>second</u> and preferred recommendation is that there be no narrower band service allocation since all of the needed telephone functions are realizable as a subset use of the

wide band. Both data and voice services can be realized and simultaneously used in the same frequency space with a common chipping rate and specialized coding.

Technical support and detail for these recommendations in given in following sections.

ACCOMMODATION RECOMMENDATION

This respondent is well aware of the competitive pressures in this matter, and more particularly for new space for the more recent methods of providing a pocket telephone service. Those methods using TDMA or FDMA do not represent either new or general philosophies that are now needed. As a minimally objectionable compromise, the following arrangement for three bandwidths is recommended:



It is further recommended that users of the data or integrated voice-data service be allowed two modes: 1) use of the center 10 MHz, or 2) use of the entire band, with no guarantees of non-interference from the narrower band services.

It is recommended that the compatibility between these different bandwidth services be regulated on a pure and simple energy density where the narrowband services are evaluated with all possible simultaneous use considered.

It is further recommended that frequency accuracy be assigned a value of approximately ±1% of the bandwidth of the operating channel rather than an absolute value that is identical for all bandwidths.

EMERGING TECHNOLOGY RECOMMENDATION

All users of the frequency space should have a common chipping rate, e.g. 15 Mchips/sec, occupying 20 MHz with a common peak power and energy density distribution. The partitioning of this capacity could be left, for now, to the market place. It is absolutely certain that all of the advocated services could be rendered within this type of constraint.

The data users would have a short symbol and a high transfer rate with short transmissions. The pocket telephones could also do the same thing, or in the alternative use longer symbols with code division channels. There might be 7-12 codes used to deal with overlapping coverage and reuse, and sequential telephone burst; or there could be long symbols and a larger number of channels.

It would be up to users to decide to allocate the proportions of code space spent on exclusivity and capacity. There will be a choice of separation of unrelated systems by geography, code or address logic.

It is imperative that the rules contain the limitation that transmission is only permitted for useful communication or overhead functions. For infrastructure access-points acting as a beacon and service available marker, there should be a duty cycle limit of about 1 to 5% of air-time.

The relative capacity for each service and application will not be decided by the rules. The rules will create a common highway for use as needed. The suppliers and their customer's will decide on the most effective of coding the common transmission rate.

RESPONDENT'S FUNCTIONAL GOAL FOR THE 1910-1930 MHZ UNLICENSED BAND

The bias of these comments are based on the following stated goals. It is further believed that the necessary alignment of technology, regulation and commercial practicability is possible.

These goals immediately create issues. The objections that that purport to be technically or economically based are often made without appropriate and necessary effort.

Great things can be done when the business incentives are present and which will be created by an unfragmented market.

User Stations

The served stations are primarily battery-powered telephones, computers, robots, automated devices, instruments or combinations of these.

Places of Use

These stations largely operate on private business premises such as offices, factories, laboratories, warehouses and hospitals. Some premises are public access facilities including shopping malls, hotel lobbies and meeting rooms, convention centers, transportation terminals, theaters and university campi. These places are commonly geographically distinct and separate, though not always or completely.

New Rather Than Duplicative Services

Though most such places are now penetrated by cellular telephone coverage, the service provided should be new, rather than a duplicative capacity extension. The key new service is high-transfer-rate packet data, far better suited to bandwidth-on-demand connection-type services which include compressed speech, facsimile and video. These are services which are at least economically uncompetitive if provided by voice-only systems currently in use or proposed.

Maximizing Capacity Using Shorter Radio Paths and Reuse Distance

To provide great capacity in small spectrum requires smaller coverage area per access-point (antenna).

It is also important to use modulations which are resistant to Rayleigh fading and like-signal interference. The one-time occupied spectrum benefit that non-spreading modulations might provide, is not actually realizable because of the reduction in fade margins and required signal-to-interference ratios obtained with the wider band modulations.

Cost and Size Objectives Attained in Part by a Common Air-Interface

The economic goals require a common air interface, so that radio components can be produced in the highest quantities. Radios the size of a "soda cracker" (thickness matters) are possible for both user computer/handset and for the radio access-points.

User Benefits

The common air-interface benefits users. The installation of separate but co-located wireless access infrastructures for each category of service is not only costly, but will very likely be subject to undesirable interactions.

The common air-interface is the central requirement for the user station to be equally operable with private and service provider supplied infrastructure.

Existing Telephone Wiring

It is not a goal to replace telephone wiring. It is a goal to provide wireless access to non-fixed or often-moved persons or functions by the most economical methods; and this requires continued use of structured telephone wiring to network the distributed antennas (access-points).

THE TECHNOLOGY WHICH SHOULD EMERGE

It is imperative that spectrum be used in large blocks so that capacity is not owned but used by those who are qualified. The separation of independent users must be done with addressing and logic and not by radio design.

The lesson that the traditional private and public radio system operators should learn from computer communication is the flexibility, capacity and relative simplicity of shared mediums with a defined access protocol. A physical medium should be no more than a high-rate bits bearer. Once there is frequency, time or code channelization, it puts the radio designers into the design of access method; and it requires those with protocol skills to know much more about radio than they ever can possible achieve.

It is quite clear now that communication is a digital message whether it is used for voice, data or video. The communication technologies which are specialized to one of these are completely unsatisfactory for the future. If the regulators acquiesce to the obvious pressure from suppliers and operators of such specialized systems, there is no way out. The regulators will then have to quantify the capacity allocated to each, and lock-in such choices for decades.

Present channelized methods are miserably ineffective in dealing with bandwidth on demand. That is understood in parts of the telecom community or there would be no pending development of switches using Asynchronous Transfer Mode (ATM).

The philosophy of ATM cells (48 octets payload plus 5 octets header) provides a method of processing and routing which is independent of the nature or bandwidth of the traffic. There may be room to argue about the length of a short packet and the detail of the header format, but there is no room to question the philosophy and functional objective.

Continued compartmentalization and a little piece for each of the strong contenders os a "Solomon" type decision which is notably fair in treating all interests equally, but it is bad for the efficiency of the end result. There should be no sub-partitioning of this 20 MHz band. Somewhere the line must be drawn, and a new philosophy tried. The existing philosophy of a piece for each category should not be pushed any further.

TECHNICAL AND ECONOMIC DETAIL CONSIDERATIONS

This new band is best used for large scale and high capacity systems having large economic significance to the USA. Now taken up are issues and positions that relevant to the choices that must be made.

Radio Cost

The first step in minimizing radio cost is to define an architecture where the radio, signal processing and protocol functions are fully separate. Because radios can be channelized and measure signal strength, the lines between these functions have been unnecessarily complicated in many past designs. All of the protocol functions of the system should be implemented through the information impressed upon the bit stream.

To maximize the volume for the control and logic parts, the frequency dependent portion of the radio should be completely separable from the logic. This is not the case with a channelized plan linked to the frequency assignements of a particular administration.

From the beginning, it is necessary to define plural antenna diversity operation and a method of selection or combining. It is very important that such measures remain independent of the access method.

Frequency Accuracy

A second step in minimizing radio cost is minimizing precision in bandwidth and center frequency. Many radio modulation methods will tolerate or correct a frequency offset between receiver and transmitter of 1% of channel bandwidth. If the bandwidth is 20 MHz, this is ±200 KHz tolerance. If the bandwidth is 125 KHz, it is 1.25 KHz which is near 0.75 ppm at 2 GHz. The wideband radio needs 160 times less accuracy, and therefore might use a local oscillator controlled by a ceramic resonator.

The narrow-band radio can only be built with a laboratory standard accuracy of local oscillator and a synthesizer to bring it to operating frequency. At a minimum, this further increases battery drain.

The required frequency accuracy should be specified as about 1% of channel bandwidth. It is suggested that the rules might use the following schedule:

Bandwidth:	20	1.25	0.1	MHz
Accuracy:	200	12.5	1.0	PPM

Frequency Division Channelization

A further step in minimizing radio cost is avoiding frequency division channelization. Channel selecting synthesizers for small fractional bandwidths or with very rapid stepping times are more difficult, complex and costly.

This precision is also applicable to bandfilters that limit susceptibility to interference and radiation outside of the assigned spectrum.

Minimization of Gain

A further step in minimizing radio cost is reducing overall gain, and the proportion of that gain that is provided by radio and intermediate frequency amplifiers. Since the output level is fixed at that suitable for logic level processing, 0/3.3 volts, and since the thermal noise limit is a bandwidth function, a radio with 1/160th of the bandwidth needs 1/160th of the gain, a reduction of 22 dB. Appropriate design would provide more of this gain at baseband and less of at RF and IF to reduce current drain.

The reduced gain is a minor improvement in cost, but the reduced shielding, bypassing and power supply isolation required is significant. This is a factor in reduced cost for wideband radio.

Relative Cost of Wide and Narrow Band Radio

All of these factors, and with more to be presented below, indicate there is no inherent lower cost in voice bandwidth radios relative to data bandwidth at a 2 GHz operating frequency. When produced in like volume, wideband data will be less costly and smaller power drain.

The use of multiple narrow-band channels cannot be justified for voice service on the basis of inherent radio cost. The wideband radio is inherently least cost given equal volume.

Motivation for Wideband Transmission

There is slight connection between absolute bandwidth and spectrum efficiency. Provided there is sufficient traffic load, any bandwidth can be spectrum efficient with appropriate technology.

There is a critical dependency on available bandwidth to offset the degradations of fading and time dispersion--two symptoms of multipath propagation. Using direct sequence spread spectrum, the period of a chip defines the minimum difference in path length for two rays which can be resolved as separate signals. If the path difference is less, as it usually is when a second path comes from floor bounce, then there may be cancellation fading of the composite signal.

Table II -- Resolvable Path Length Difference vs. Bandwidth

Available Bandwidth	Chipping Rate	Chip Period	Path Difference
10 MHz	7.5 Mchips/sec	133 nanosec	40 meters
20	15	66.5	20
40	30	33.3	10
80	60	16.7	5

Example: At a chipping rate of 15 Mchips/sec, the receiver can resolve a path length difference between the direct and reflected ray of more than 20 meters. The receiver may be only slightly degraded if the path difference is as little as 15 meters. If the difference is less than 10 meters, there will be Rayleigh distributed fading with the possibility of significant decrease in level from cancellation. If the difference is more than 15 meters, the receiver has the possibility of detecting the second path separately and using it as a diversity gain factor.

This conclusion is <u>independent of the symbol length used and the realized data rate</u>. The longer the symbol, the lower the realized transfer rate and the noise bandwidth.

The consequence of inability to resolve the second path is a need for more fade margin, and increased ability of the receiver to cope with sudden phase reversals of the radio signal as it passes through a fade. This could be important enough to make impractical phase coherent detection which would be worth 3 dB in power and some occupied bandwidth penalty.

Apart from the use of time diversity, <u>any increase in required fade margin, will have a direct effect on minimum spacing of co-channel users</u>; and it will decrease the effectiveness of listen-before-talk transmitter inhibiting methods.

For reference, a data transfer rate of 4.28 Mbits/sec is estimated for the feasible data rate with 15 Mchip/sec. If the quadrature phase is used in the medium, the transfer rate can be doubled.

20 MHz is already at a point where the value of time diversity is impaired for short reach systems. 10 MHz of bandwidth would make time diversity nearly valueless.

Power and Range

One of the most important decisions that can be made is to specialize the band for short-reach, battery-powered equipment depending primarily on non-obstructed radio paths. The selection of the maximum peak power is prejudicial against such equipments if it is higher than they actually need. Further, excess allowable power increases the excess coverage that creates interference between contiguous systems.

Those who would seek to cover the interior of a building with one access-point, will want all the power that is available. This is the base-station-for-10 "mind set." It must be accepted, to a much greater degree than in cellular or most PCS proposals, that area is covered by a sufficient number of access-points. The historic cost objections are simply not valid in the context of building interiors and short reach.

Power level

A 100 milliwatt transmitter power limit corresponds to 40 meters with two octaves of moderately obstructed path within the range limit, 10 MHz noise bandwidth, margin for 10^{-6} BER and 6 dB demodulator loss and 10 dB noise figure and a further 13 dB fade margin. This does not include the improvements that can be obtained with access-point antenna directivity and diversity. The noise bandwidth is appropriate for data at high transfer rates, and would be much lower for a voice radio.

Served Users per Access-point as a Function of Range

The square inscribed in a 40 meter radius, would have an area of 3,200 m^2 or more than 32,000 ft^2. At the average user density of office desks (1/150 ft^2), this range is enough to cover 220 desks. Much less range would still cover enough area to enclose 12 users--a number thought to be about the right average number to economically support an access-point. Also, the user density for the given area might be lowered to 1/2,660 ft^2.

I do not see a justification for more than 100 milliwatts. It is always the case that coverage holes are reduced with more power, but far more system capacity is provided if such cases are mitigated with wideband modulations that are less susceptible to cancellation holes and with multiple antenna diversity at both station and access-point.

Capacity

With one particular possible set of assumptions about radio technology, one coverage using the full bandwidth would result in a data transfer rate of 5 Mbits. If coverage overlap calls for a reuse value = 4, then each site in groups of four can only be used on the average of 25% of the time. In practice the traffic between sites might adaptively distribute according to demand making possible a 30, 20, 35, 15 % partitioning at some instant.

The capacity per access point might average 1.25 Mbits/sec with a capability of 2 Mbits/sec at peaks.

If one access point covers 10,000 ft^2 (with a reach of 71 ft), that would be 12.5 Mbits/sec per 100,000 ft^2 (one hectare). If the reuse number can be reduced to two, as is probable, this number can again be doubled. It could also be doubled by reducing the range to 50 ft.

For pocket telephones, and considering that full packets are only transferred when there is voice activity, the capacity used after duplexing might be 80% rather than 50% for full time in both directions or 1 Mbit/sec. This corresponds to about 30 voice channels coded 32 Kbit/sec per access-point.

These numbers are offered, not as conclusions or recommendations or even roughly accurate estimates, but to illustrate the methodology for converting transfer rate in the number of users and sustainable user density. Improving technology will with time increase the capacity of the channel from 0.25 bits/Hz to higher values.

CONCLUSION

In the longer term, the most usefulness would be derived from this 20 MHz if it were used as a wide share highway with each user only transmitting when traffic was transferred. By avoiding unused space reservation that arises from fixed partitioning, the use of the space as a whole may be better matched to needs even though those needs vary in their mix with time.

The packet technology to do this is already evolving and could take the form of a last 40 meters local distribution system for ATM cells.

Respectfully submitted,

Chandos A. Rypinski
LACE, Inc.
655 Redwood Highway #340
Mill Valley, CA 94941